OUTLINE OF RESEARCH WORK ENTITLED

Study On Solutions For Heat Transfer Equation Using Different Methods

Submitted to

Swami Ramanand Teerth Marathwada University, Nanded

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By

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1 Introduction

Heat transfer is a discipline of thermal engineering that concerns the generation, use conversion, and exchange of thermal energy (heat) between physical system. Heat Transfer is the study of thermal energy transport within a medium or among neighbouring media by molecular interaction. Heat Transfer is divided into different mechanism, such as **thermal conduction**, **thermal convection, thermal radiation**. Engineers and mathematician is to problem faced to find the solutions of the governing equations. Engineers also consider the transfer of mass of differing chemical science.

The Heat Transfer coefficient is expressed as **nonlinear function**, where as thermal conductivity is expressed as a **linear function** allowing both to be temperature dependent. Heat Transfer always obtained from a neighborhood of **high temperature** to another neighborhood of **lower temperature**, as described in the second low of thermodynamic. A thermal system contains matter or substance and this substance may change by transformation. Thermodynamics is used to perform a thermal analysis of a system. Which allows for quantitative description of the substance. The boundaries of the system which is the done by applying the principle of conservation.

The application of Heat Transfer has broad functioning of numerous devices and system. The principle of Heat Transfer may be used in the wide variety of circumstance of temperature is increase or decrease. Heat Transfer methods are

used in numerous discipline, such as automative engineering, thermal management of electronic devices and systems, climate control, insulation, materials processing, chemical engineering and power station engineering.

2 Review of Literature and Development in the Subject

(previous work done in the relevant type)

Heat Transfer Equation is the most well known and valuable branch of mathematics and physics. Many transform method often require complicated technique and elaborate work to overcome mathematics difficulties for nonlinear transient problem.

- In 2003. P. M. Jordan, [1] is nonstandard finite difference scheme is constructed to solve an initial-boundary value problem involving a quartic nonlinearity that arises in Heat Transfer involving conduction with thermal radiation.
- In 2007. Hsin-Ping Chu et al. [2] is a hybrid differential transformation-finite difference method to analyze nonlinear transient heat conduction problem. The differential transformation technique is used to transform the governing equations from the time domain into the spectrum domain, followed by use of the finite difference method to formulate discretized iteration equations appropriate for rapid computation.

- In 2008. Kulkarni V.C. et al. [3] studied the thermal stresses in a thick annular disc with different boundary conditions. The governing heat conduction equation has been solved by using integral transform technique.
- In 2010.Deshmukh K. C. et al. [4] considered a simply supported rectangular plate and discussed the deflection with the help of resultant moment. Also evaluated the thermal stress component due to thermal bending and shearing stress function.
- In 2013. Partner L. Ndlovu, [5] is the analytical solution for the temperature distribution in a longitudinal rectangular and convex parabolic fins with temperature dependent thermal conductivity and Heat Transfer coefficient are divided. The transient heat conduction problem is solved for the first time using two-dimensional differential transform method (2D DTM).
- In 2013. Aksoy, [6] compared results of the homotopy analysis method with numerical results of the finite difference method for the thermal analysis of annular fins with temperature dependent thermal properties.
- In 2016. Yang, X. J., [7] is A New Integral Transform with An Application in Heat-Transfer Problem. An new integral transform is proposed for the first time. The integral transform is used to solve the differential equation arising Heat Transfer Problem.
- In 2017. Yang, X. J., [8] is A New Integral Transform Method for Solving Steady Heat-Transfer Problem. a new Integral Transform method for the

first time. It is used to find the solution for the differential equation in Steady Heat-Transfer problem.

- In 2018. Md. Amirul, [9] consider a Crank-Nicolson algorithm for solving one-dimensional Heat Equation. In numerical analysis the Crank-Nicolson method is a finite difference method used for numerically solving the Heat Equation and similar partial differential equation.
- In 2019. S. Maitama, [10] is a new Laplace-type integral transform (NL_TIT) for solving steady-heat transfer problem. The proposed Laplace-type integral transform converges to both yang transform, and the Laplace transformation just by changing variable.
- In 2021. J. R. Wadkar, [11] is the determination transient temperature distribution in a thick straight rectangular fin. Initially, the fin is kept at a constant temperature. Convection due to occurs at all other boundary surface. The thermal properties of the material of the fin are assumed to be temperature dependent. The governing nonlinear differential equation is solved by finite difference method.
- In 2022. J. R. Wadkar, [12] employed a hybrid differential transformation-finite difference method used to solve the nonlinear transient heat conduction problem. The differential transformation method is used to shift the governing equations from the time domain to the spectrum domain,

followed by the suitable for rapid computing using the finite difference method.

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3 Methodology to be Adopted

The mathematical solution of Heat Transfer Equation can be solved by using the different method. The methods are differential transform method, finite difference method, integral transform method or by finite element method. Mostly, I will be referring the research papers of several researchers who have developed this area of research. I also consult with my thesis supervisor time to time to discuss the doubts.

1. Differential Transform Method

The Differential Transform Method is a numerical method based on Taylor series exapansion. This method constructs an analytical solution in the form of polynomial. Since it was developed by Puhove [13]. An application of this method is to solve both linear and nonlinear initial value problem in electric circuit analysis.

2. Finite Difference Method

The Finite Difference Method is one of the several technique for obtaining the numerical solution to the boundary value problem [14]. Finite Difference Method (FDM) were used extensively in the 1960. Now a day finite difference method

(FDM) is a powerful tool for the approximate solution of differential equations governing diverse physical phenomena. Finite difference method is one of the numerical methods that are known as highly applicable method in a lot of scientific fields.

3. Integral Transform Method

In the past almost two centuries, integral transform method (ITM) [15] have played an important role in the area of mathematical physics and engineering science such as fluid mechanics, viscoelasticity, chemistry, physics, finance.

In the mathematical literature, the famous classical integral transforms used in differential equations, analysis, theory of functions and integral transform are the Laplace transform [16] which was first introduced by a French mathematician Pierre-Simon Laplace is especially attractive for transient and steady state heat conduction problem.

4. Finite Element Method

The Finite Element Method (FEM) is a popular method for numerically solving differential equations arising in engineering and mathematical modeling. The (FEM) subdivides a large system into smaller, simpler parts that are called **finite element method.** The finite element method obtained its real impetus in the 1960 and 1970 by the development of J. H. Argyris. The finite element model of problem gives a piecewise approximation to the governing equations.

4 Importance of Study

This work has wide scope of applications. Applied mathematics has long provide a rich source of motivation for development in Heat Transfer Equation, also the Heat Transfer Equation plays an important role in linear and non linear system. The area of my research is highly applicable in several real-world phenomena of different fields of science, applied mathematics and engineering. The solution of Heat Transfer Equation solved by different method. The methods used are differential transform, finite difference and integral transform method, finite element method, method of separation of variable and MATLAB software.

5 Objectives of Research

This thesis covers some analysis for the study of solution of Heat Transfer Equation by using different method as per the condition of problems.

The main aim of our present studies are:

- Understand the concepts of Heat Transfer equation, their solution and applications.
- Analyze the issues identified using previous work and understanding of the problem.
- We review and derive some relevant results and numerical solution on Heat Transfer Equation.

- To discuss the Heat Transfer and thermal stress analysis of metallic solids subjected to radiative heat flux.
- To develop the generalized technique to analyze Heat Transfer Equation with different methods.
- To develop mathematical models for the purpose of Heat Transfer and thermal stress analysis of thin and thick metallic solids subjected to large temperature variation.

6 Proposed Work Plan

Following is the Year-wise plan of work and target to be achieved during my research period:

Year 1: Course work: I would like to complete the course work which is declared by SRTMU Nanded. Then after, I would like to start area of my research background knowledge to be understand. And read some text book. I will start reading some research paper of various researcher in the area of my research topic. I also plan to participation of scientific workshop, meeting, conference, seminars, short time research visit are expected during the Ph.D. project.

Year 2: In the domain of my research topic, I plan to the collected material will analyzed and discover finding the direction towards a research. Different methods will be used to solve the problems, and also the read and write some research article.

Year 3: More than four scientific papers are expected to be published /presented in the National, International Conference/Journals. The result will be presented at least two International Conference with few dedicated workshops.

Year 4: Finally, I will write the thesis and checking the anti-plagiarism then printing and binding the thesis will be done for submitting the thesis to the university.

7 Thesis Layout

- **Chapter 1:** Introduction and Overview.
  1.1- Introduction.
  1.2- Review of Literature and Development in the Subject.
  1.3- General Notations.
- **Chapter 2:** Methodology for Solving Heat Transfer Equation.
- **Chapter 3:** Analysis of Heat Transfer with Temperature Dependent Porperties.
- **Chapter 4:** Application of Heat Transfer Equation.
- **Chapter 5:** Discussion and Conclusion.

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Research Student

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Research Guide

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